REMARKS

I. Introduction

Applicant respectfully requests reconsideration of the present application in view of the foregoing amendments and in view of the reasons which follow. After amending the claims as set forth above, claims 1-19 are now pending in this application. Claims 1, 4, 5 and 7 were amended. Claims 8-14 were added.

Support for the upper range endpoint of the silicon content in claims 1, 4, 5 and 7 is found in example 3 of the specification (Table 1, page 9, row 4, column 4). Support for the lower and upper range endpoints of the combined chromium and molybdenum content in claims 1, 4, 5, 7 and 21-24 is found in example 2 of the specification (Table 1, page 9, row 3, columns 7+8 (2.03 wt % Cr + 0.68 wt % Mo = 2.71 wt % Cr+Mo)) and in example 1 of the specification (Table 1, page 9, row 2, columns 7+8 (3.01 wt % Cr + 0.45 wt % Mo = 3.46 wt % Cr+Mo)), respectively.

Support for claims 8, 13 and 16 may be found, for example, in originally filed claims 2 and 3. Support for claims 9 and 17 may be found, for example, on pages 14-15 of the specification. Support for claims 10, 11, 18 and 19 may be found, for example, in originally filed claims 4 and 7. Support for claims 12, 14 and 15 may be found, for example, in originally filed claim 6. Support for claim 20 is found throughout the specification and original claims, especially in Table 1. No new matter was added.

II. The § 112 Rejection Should Be Withdrawn

Claims 1-7 are rejected under 35 U.S.C. 112, first paragraph, as not being enabled for their full scope because the claims do not recite the upper limit on the silicon content in the claimed steel. This ground of rejection is respectfully traversed. The PTO posits that the claims can include compositions having Si

contents of up to 50%. Of course, it is always possible, in the case of any "open-ended claims," to include something in the claims that will cause the claims to be non-enabled, e.g., the claims also are open to the inclusion of some other unnamed element. However, this is not the proper approach. Instead, the issue of enablement must be understood in terms of a person of ordinary skill in the art, which means that open-ended claims are not to be interpreted as including elements or amounts of elements that a person of ordinary skill in the art understands not to be present. In the present case, the silicon content in the basic alloy compositions is acknowledged to be known in the art, and the prior art cited in the Office Action so demonstrates. As is evident from the prior art and the present specification, persons skilled in the art recognize that only relatively small amounts of Si are included in such alloys, e.g., up to a few percent. Thus, applicants' claims are to be understood in this context, i.e., it would not involve "undue experimentation" to determine the upper boundary of the Si content in the claimed alloys. Applicants should not have to recite some strict limitation for the upper Si content, which is not an aspect of their invention, since this only provides an invitation for someone to easily avoid a literal infringement of the claims.

Consequently, applicants have adopted the approach in new claim 20 of defining the amount of Si as "a relatively small amount of not less than 0.4 % by weight." This language is supported by all of the examples in the application, in which only a "relatively small amount" of Si, but at least 0.4 %, is present, and is also shown by the prior art that relates to similar alloys. Applicants respectfully submit that claim 20 is fully enabled.

Without acquiescing to the propriety of the rejection, applicants have amended the original independent claims to recite that an upper endpoint of the range of silicon content in the steel is 1.23 percent by weight. By the amendment, applicants do not intend to surrender any range of available

equivalents under the doctrine of equivalents, inasmuch as a person skilled in the art understands that somewhat higher amounts of Si can also be present in the alloys.

III. The § 103 Rejections Should Be Withdrawn

Claims 1-3 and 5-6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Watari (US 5,922,145) in view of "Annealing of Steel". Claims 4 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Watari in view of "Annealing of Steel" as applied to claims 1-3 and 5-6 above, and further in view of "Introduction to Surface Hardening of Steels" and "Tempering of Steel". Claims 1-3 and 5-6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Eguchi (US 5,746,842) in view of "Annealing of Steel". Claims 4 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Eguchi in view of "Annealing of Steel" as applied to claims 1-3 and 5-6 above, and further in view of "Introduction to Surface Hardening of Steels" and "Tempering of Steel". Claims 1-3 and 5-6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shibata (US 4,773,947) in view of "Annealing of Steel". Claims 4 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shibata (US 4,773,947) in view of "Annealing of Steel" as applied to claims 1-3 and 5-7 above, and further in view of "Introduction to Surface Hardening of Steels" and "Tempering of Steel". These rejections are respectfully traversed.

Independent claims 1, 4 ,5 and 7 have been amended to recite that a total amount of chromium (Cr) and molybdenum (Mo) in the steel is within a range of from 2.71 to 3.46 % by weight. By the amendment, applicants do not intend to surrender any range of available equivalents under the doctrine of equivalents.

This total amount range provides the following unexpected advantages not taught or suggested by the applied prior art references.

As discussed on pages 1-2 of the present application, when a low temperature heat treatment is performed on the machine structural steel, the hardness of the steel remains higher than desired so that machining or cutting of the steel is made difficult. When the heat treatment of the steel is accomplished at relatively high temperatures, such as a normalizing heat treatment, the hardness of the steel is lowered. However, as also discussed in the middle column on page 47 of "Annealing of Steel", the machine structural steel becomes excessively soft and "gummy". This leads to formation of gouges during machining or cutting of the steel, thereby degrading the machining precision and the quality of the manufactured part.

The formation of the gouge can be improved by heat treatment in a spheroidizing temperature range for a long time. During this heat treatment spheroidized carbide is formed in the steel. However, the size of carbide becomes large, thereby shortening the life of a tool used for machining the steel.

In view of these problems, the inventors have investigated the relationship between the size of the spheroidized carbide and the life of the machining tool. The inventors discovered that it is beneficial to minimize the particle size of the spheroidized carbide for the purpose of prolonging the life of the tool, as discussed on pages 5-6 of the specification. In order to minimize the particle carbide particle size, a relatively large amount of Cr and Mo is added to the steel, as discussed in the last paragraph on page 5 of the specification. As illustrated by examples 1-3 in the present specification, the carbide particle size in reduced when the total amount of Cr and Mo content in the steel is at least 2.71 weight percent, preferably between 2.71 and 3.46 weight percent. By adding this relatively large amount of Cr and Mo to the steel, the particle size of the spheroidized carbide is minimized, thereby prolonging the life of the tool used for machining the steel. This unexpected result is not taught or suggested in the applied prior art reference.

A. The Rejections Over Watari Should Be Withdrawn

Watari teaches that the Cr content in the steel should not exceed 2 wt % and that the Mo content should not exceed 0.5 wt % (col. 2, lines 67-68 of Watari). Thus, Watari teaches a maximum Cr + Mo content of 2.5 wt %, which is below the lower range endpoint of 2.71 wt % Cr + Mo recited in the pending independent claims. Furthermore, there is no motivation to increase the Cr and Mo content in the steel of Watari because Watari explicitly teaches away from increasing the Cr + Mo content above 2.5 wt %. In column 9, lines 1-11, Watari teaches that Cr content should not exceed 2 wt % because it would impair the endurance and yield ratio of the steel. In fact, Watari teaches that Cr content of 1.5 wt % and less is actually preferred. In column 9, lines 12-22, Watari teaches that Mo content should not exceed 0.5 wt % because it would lower the fatigue strength of the steel. Thus, there is no motivation to increase the Cr + Mo content of the steel of Watari to meet the range recited in claims 1, 4, 5 and 7. Thus, the combination of Watari and Annealing of Steel does not teach or suggest all claim limitations of the pending independent claims.

B. The Rejections Over Eguchi Should Be Withdrawn

Eguchi teaches that the Cr content in the steel should not exceed 2.5 wt % and that Mo content should not exceed 0.7 wt % (Abstract and col. 4, lines 1-13 of Shibata). However, Eguchi does not teach that a high amount of Cr and Mo should be used together such that the Cr + Mo content is 2.71 wt % or above. In fact, Eguchi teaches that a high Cr and Mo content is detrimental to the properties of the steel.

Eguchi teaches that Cr content above 2.5 wt % results in an excessively high hardness which leads to a deterioration of machinability. Thus, the Cr content in preferably maintained below 2 wt % (col. 6, lines 31-42 of Eguchi). Likewise, Eguchi teaches that Mo content above 0.7 wt % saturates its effect

and results in an economical disadvantage. Thus, Mo content of 0.5% and below is more desirable (col. 6, lines 42-53 of Eguchi). Therefore, Eguchi suggests that a maximum Cr + Mo content of 2.5 wt % is desirable.

Furthermore, the numerous specific examples of steel compositions in Tables 1, 3 and 5 of Eguchi do not teach or suggest the claimed composition ranges of elements recited in the independent claims of the present application. Thus, when the entire disclosure of Eguchi is viewed as a whole, it does not teach or suggest the steel composition recited in the independent claims of the present application.

Furthermore, Eguchi teaches that the steel is subjected to a carburizing heat treatment at 900 °C (col. 8, lines 8-12 of Eguchi). This temperature is much higher than a spheroidizing heat treatment temperature, which in the preferred embodiment of the present invention is about 700 to about 820 °C (see page 7, lines 20-27 of the present specification and claim 6).

The Annealing of Steel textbook on page 47, middle column, states that low carbon steels are seldom spheroidized for machining. Therefore, Annealing of Steel textbook does not provide motivation to lower the heat treatment temperature of the low carbon steel of Eguchi to the spheroidizing heat treatment temperature range which will form spheroidized carbide precipitates. Thus, the combination of Eguchi and Annealing of Steel does not teach or suggest all claim limitations of the pending independent claims.

C. <u>The Rejections Over Shibata Should Be Withdrawn</u>

Shibata teaches that the Cr content in the steel should not exceed 2 wt % and that Mo content should not exceed 0.5 wt % (Abstract and col. 4, lines 1-13 of Shibata). Thus, Shibata teaches a maximum Cr + Mo content of 2.5 wt %, which is below the lower range endpoint of 2.71 wt % Cr + Mo recited in the pending independent claims. Furthermore, there is no motivation to increase the

Cr and Mo content in the steel of Shibata because Shibata explicitly teaches away from increasing the Cr+Mo content above 2.5 wt %. In column 4, lines 10-13, Shibata teaches that Cr content should not exceed 2 wt % and that Mo content should not exceed 0.5 wt % because the steel will become inferior in toughness. Thus, there is no motivation to increase the Cr+Mo content of the steel of Watari to above 2.5 wt % to meet the range recited in claims 1, 4, 5 and 7.

Furthermore, Shibata teaches that the steel is subjected to a normalization anneal at 925 °C prior to machining the steel into bars (col. 5, lines 3-5). This temperature is much higher than a spheroidizing anneal temperature, which in the preferred embodiment of the present invention is about 700 to about 820 °C (see page 7, lines 20-27 of the present specification and claim 6).

The Annealing of Steel textbook on page 47, middle column states that low carbon steels are seldom spheroidized for machining. Therefore, Annealing of Steel textbook does not provide motivation to lower the normalization annealing temperature of the low carbon steel of Shibata to the spheroidizing heat treatment temperature range which will form spheroidized carbide precipitates. Thus, the combination of Shibata and Annealing of Steel does not teach or suggest all claim limitations of the pending independent claims.

D. Claim 20

With respect to newly added independent claim 20, the claimed composition patentably distinguishes over the cited references because none of the references explicitly discloses a composition within the claimed compositional ranges and having the claimed carbide microstructure, and the prior art completely lacks an appreciation of the relationship between selecting the total combined content of Cr and Mo, along with the heat treatment parameters, such that the claimed carbide microstructure is produced.

Specifically, claim 20 recites that the total amount of chromium and molybdenum and the conditions of spheroidizing heat treatment are selected such that the carbide has an average particle size of not larger than 1 μm and a maximum particle size of not larger than 3 μm. The prior art does not teach or suggest this limitation. Without such a "teaching" in the prior art, as discussed above, the claimed invention cannot be said to be "obvious" within the meaning of Section 103. Claim 20 accurately defines applicants' unobvious contribution vis-à-vis the prior art.

IV. Conclusion

Applicant believes that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested.

The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

Respectfully submitted,

Date 11/4/02

By [signature]

Leon Radomsky
Registration No. 43,445

FOLEY & LARDNER
Washington Harbour
3000 K Street, N.W., Suite 500
Washington, D.C. 20007-5143
Telephone: (202) 672-5300
Facsimile: (202) 672-5399

002.917650.1

MARKED UP VERSION SHOWING CHANGES MADE

Below are the marked up amended claim(s):

1. (Amended) A steel for a high bearing pressure-resistant member, having a high machinability, said steel being formed of a machine structural steel comprising carbon in an amount ranging from 0.15 to 0.25% by weight, silicon in an amount of not less than 0.4 % by weight <u>and not more than 1.23 % by weight</u>, nickel in an amount ranging from 1 to 3 % by weight, chromium in an amount ranging from 1.2 to 3.2 % by weight, and molybdenum in an amount ranging from 0.25 to 2.0 % by weight, <u>a total amount of chromium and molybdenum amounting to at least 2.71% by weight</u>, said machine structural steel containing carbide precipitated under a heat treatment for spheroidizing, the carbide having an average particle size of not larger than 1 μm and the maximum particle size of not larger than 3 μm.

4. (Amended) A high bearing pressure-resistant member made of a steel which has a high machinability and is formed of a machine structural steel comprising carbon in an amount ranging from 0.15 to 0.25% by weight, silicon in an amount of not less than 0.4 % by weight <u>and not more than 1.23 % by weight</u>, nickel in an amount ranging from 1 to 3 % by weight, chromium in an amount ranging from 1.2 to 3.2 % by weight, and molybdenum in an amount ranging from 0.25 to 2.0 % by weight, <u>a total amount of chromium and molybdenum amounting to at least 2.71% by weight,</u> said machine structural steel containing carbide precipitated under a heat treatment for spheroidizing, the carbide having an average particle size of not larger than 1 μm and the maximum particle size of not larger than 3 μm,

wherein said machine structural steel undergoes one of a first treatment and a second treatment after the spheroidizing heat treatment, said first treatment including hardening the machine structural steel by carburizing, and

tempering the hardened machine structural steel, said second treatment

including hardening the machine structural steel by carbonitriding, and tempering the hardened machine structural steel.

5. (Amended) A method of producing a steel for a high bearing pressure-resistant member, having a high machinability, said method comprising:

preparing a machine structural steel comprising carbon in an amount ranging from 0.15 to 0.25% by weight, silicon in an amount of not less than 0.4 % by weight <u>and not more than 1.23 % by weight</u>, nickel in an amount ranging from 1 to 3 % by weight, chromium in an amount ranging from 1.2 to 3.2 % by weight, and molybdenum in an amount ranging from 0.25 to 2.0 % by weight, <u>a total amount of chromium and molybdenum amounting to at least 2.71% by weight</u>; and

applying a heat treatment for spheroidizing on said machine structural steel so that carbide is precipitated in said machine structural steel, the carbide having an average particle size of not larger than 1 μm and the maximum particle size of not larger than 3 μm.

7. (Amended) A method of producing a high bearing pressure-resistant member, having a high machinability, said method comprising:

preparing a machine structural steel comprising carbon in an amount ranging from 0.15 to 0.25% by weight, silicon in an amount of not less than 0.4 % by weight <u>and not more than 1.23 % by weight</u>, nickel in an amount ranging from 1 to 3 % by weight, chromium in an amount ranging from 1.2 to 3.2 % by weight, and molybdenum in an amount ranging from 0.25 to 2.0 % by weight, <u>a total amount of chromium and molybdenum amounting to at least 2.71% by weight</u>;

applying a heat treatment for spheroidizing on said machine structural steel so that carbide is precipitated in said machine structural steel, the carbide having an average particle size of not larger than 1 μm and the maximum particle

size of not larger than 3 μm;

machining said machine structural steel to have predetermined shape and dimensions; and

applying one of a first treatment and a second treatment on said machine structural steel after the machining, said first treatment including hardening said machine structural steel by carburizing, and tempering said hardened machine structural steel, said second treatment including hardening said machine structural steel by carbonitriding, and tempering said hardened machine structural steel.